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Article

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A new species of *Sibon* (Squamata: Colubroidea: Dipsadidae) from the Cordillera Central of western Panama, with comments on other species of the genus in the area

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Abstract

We describe *Sibon noalamina* sp. nov. from the Caribbean versant of the Cordillera Central, in the Comarca Ngöbe-Buglé and the province of Veraguas of western Panama. Due to its coral snake-like, bicolored pattern, the new species superficially resembles *Sibon anthracops, Dipsas articulata, D. bicolor, D. temporalis,* and *D. viguieri*. It differs from these species, and from all its congeners, by having only five supralabials, by the unique shape of the posterior supralabial, and by a slight keeling on some dorsal rows in adults. We discuss its conservation perspectives, and provide new distributional records for *S. annulatus* and *S. longifrenis,* as well as an updated key to the Lower Central American species of *Sibon*.

Key words: snail-eater, *Dipsas,* Chiriquí, Comarca Ngöbe-Buglé, Bocas del Toro, Veraguas, conservation, distribution extension, morphology

Resumen

Describimos *Sibon noalamina* sp. nov. de la vertiente Caribe de la Cordillera Central, Comarca Ngöbe-Buglé y provincia de Veraguas, en el occidente de Panamá. Debido a su patrón bicolor parecido a las serpientes corales, la nueva especie es superficialmente similar a *Sibon anthracops, Dipsas articulata, D. bicolor, D. temporalis,* y *D. viguieri*. Se distingue de estas especies, así como de todas las especies conocidas de *Sibon,* por tener solo cinco escamas supralabiales, por la forma única de la última supralabial, y por tener algunas hileras de escamas dorsales ligeramente quilladas en los adultos. Discutimos aspectos de su conservación y presentamos nuevos registros de distribución para *S. annulatus* y *S. longifrenis,* así como una clave actualizada para las especies de *Sibon* que se conocen del sur de Centroamérica.

Palabras clave: caracolera, *Dipsas,* Chiriquí, Comarca Ngöbe-Buglé, Bocas del Toro, Veraguas, conservación, extensión de distribución, morfología

Introduction

As presently understood, the genus *Sibon* comprises 15 species (Uetz 2012) of harmless, nocturnal snail-eaters that either present a contrasting color pattern of alternating rings similar to that of coral snakes of the genus *Micrurus,* or a rather aposematic coloration that might be considered to mimic that of arboreal pitvipers (Solórzano 2002, Campbell & Lamar 2004). Central America is home to thirteen species of *Sibon,* six of which have been reported to occur in Panama: *Sibon annulatus* (Günther), *S. argus* (Cope), *S. lamari* Solórzano, *S. longifrenis* (Stejneger), *S. nebulatus* (Linnaeus), and *S. perissostichon* Köhler, Lotzkat and Hertz (Köhler 2008, Jaramillo *et al.* 2010, Köhler *et al.* 2010, Rovito *et al.* 2012).

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Between 2008 and 2010, our fieldwork in western Panama produced several specimens of *Sibon* including *S. annulatus, S. longifrenis, S. nebulatus,* and the holotype and hitherto only known specimen of *S. perissostichon*. Moreover, we collected an adult and two juvenile specimens of *Sibon* that differ from all Panamanian *Sibon* by exhibiting a coral snake pattern of light and dark rings, resembling that of the sympatric *Dipsas articulata* (Cope). In addition to their coloration, these specimens share pholidotic characters that easily distinguish them from all known species of *Sibon.* In the following we describe them as representative of a new species, and provide new distributional records as well as morphological data for Panamanian specimens of *S. annulatus, S. longifrenis,* and *S. nebulatus.*

Material and methods

The species description mainly follows the format of McCranie (2007) and Köhler *et al.* (2010). We list all specimens examined for comparison in the Appendix. We took additional data for the Lower Central American species of *Sibon* and *Dipsas* from Köhler (2008), McCranie (2006, 2011), Peters (1960), Rovito *et al.* (2012), Savage (2002), Savage and McDiarmid (1992), and Solórzano (2002, 2004). Abbreviations for museum collections follow those of Leviton *et al.* (1985), except for MHCH (Museo Herpetológico de Chiriquí, Universidad Autónoma de Chiriquí, David, Chiriquí, Panama). Specimens listed in the Appendix with JS field numbers will be deposited in the Museo de Ciencias Naturales de la Universidad Centroamericana (UCA), Managua, Nicaragua. We follow Dowling (1951) for the method of counting ventral scales, and Savage (1973) for the terminology of scales in the loreal region of the head. The sex of the holotype was determined by eversion of the hemipenes. Snout-vent length and tail length measurements were taken to the nearest mm along a meter stick. Head and scale measurements were made to the nearest 0.1 mm with a dial caliper under a dissecting microscope (Leica MZ 12). Head drawings were made using a camera lucida attachment for this dissecting microscope. Abbreviations for measurements are as follows: snout-vent length, SVL; tail length, TL; total length, TOL (SVL + TL); head length (measured from posterior edge of mandibular bone to tip of snout), HL; snout length (measured from anterior border of orbit to tip of snout), SL; and head width (measured at the broadest point), HW. Eye length was measured as the horizontal distance across eye. Scale dimensions were measured at the longest or widest points along the longitudinal or perpendicular axis of the body, respectively, and were taken only from the holotype. When variation in the bilateral symmetry of head scale counts is present, they are separated by a slash (right side/left side). The capitalized colors and color codes (the latter in parentheses) are those of Smithe (1975–1981). Tissue samples of all three specimens of the new taxon were cut from the edges of ventrals and first dorsal rows on the posterior half of body and deposited in the tissue sample collection of the Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt, Germany.

Geographic coordinates and altitude above sea level were recorded with a Garmin etrex Summit GPS receiver. All georeferences are in geographical coordinate system and WGS 1984 datum, and given in decimal degrees rounded to the fourth decimal place. Elevations are given in meters above sea level and rounded to the next tenth. Spatial datasets were created, managed, and analyzed with DIVA-GIS (www.diva-gis.org). The map (Fig. 4) was created using ArcGIS 10. Map layers were downloaded from the map server of the Smithsonian Tropical Research Institute (URL: http://mapserver.stri.si.edu/geonetwork/srv/en/main.home).

If not otherwise indicated, climatic data are derived from the WorldClim database (Hijmans *et al.* 2005). We conducted automatized temperature measurements at the type locality every hour from 18:00 hrs on 28 October 2009 to 12:00 hrs on 31 October 2009 using an iButton datalogger placed in closed forest next to the stream, about 30 m upstream from the position of the juvenile paratype.

Results

***Sibon noalamina* sp. nov.**
Figs. 1–3

Dipsas articulata: Köhler (2008: p. 219: Fig. 592); Stadler (2010); Carrizo (2010: in part, referring to Stadler 2010)

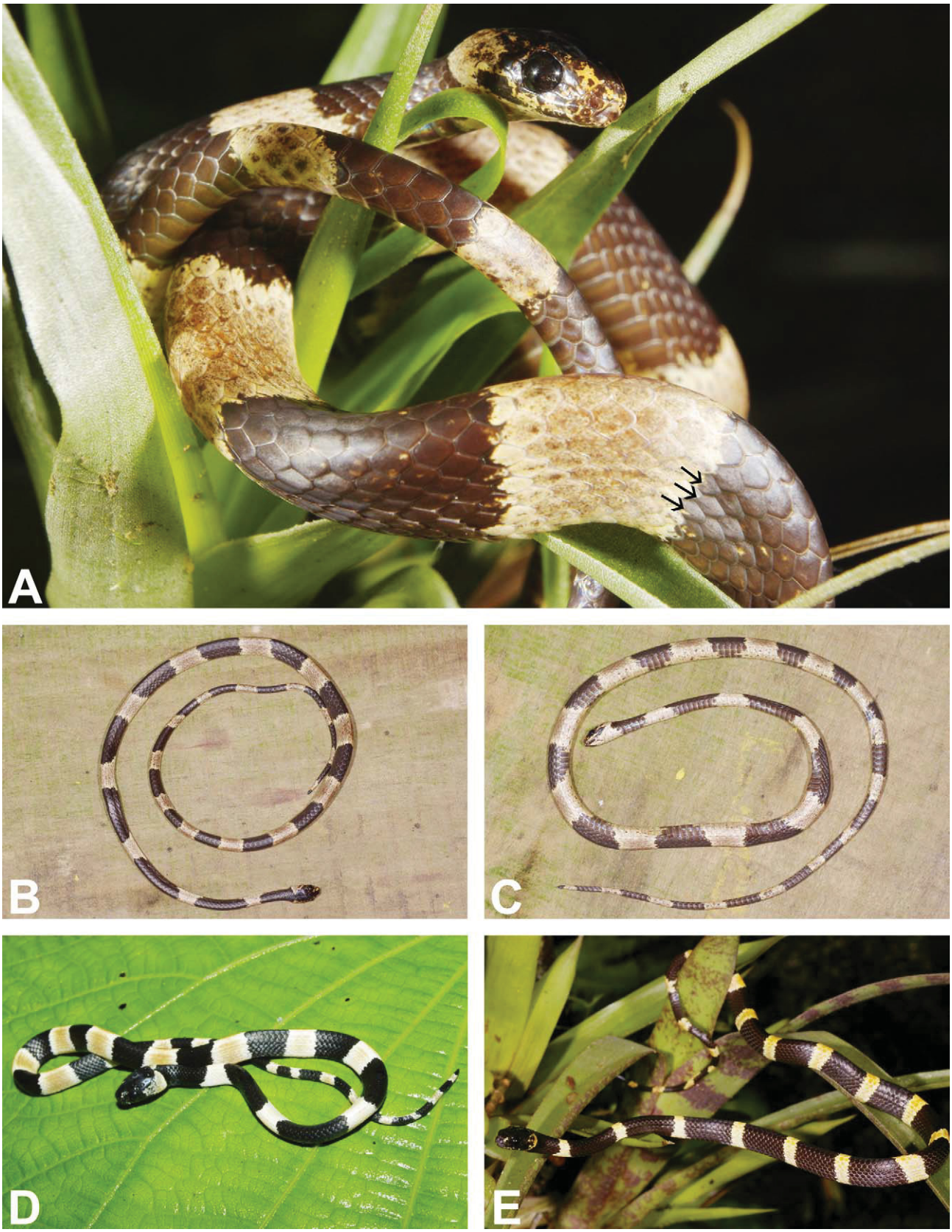

FIGURE 1. Type series of *Sibon noalamina:* (A) Holotype (SMF 91539) in life (arrows indicate dorsal rows 3–5 next to visible keels), (B) dorsolateral and (C) ventrolateral views of euthanized holotype prior to eversion of hemipenes and preservation, (D) Juvenile paratype (SMF 90180) from type locality in life, (E) juvenile paratype (SMF 89550) from Veraguas in life.

Holotype. SMF 91539 (original field number SL 775; Figs. 1A–C, 2–3), adult male, from headwaters of Río Chiriquí Malí, approximately 6.4 km NW Fortuna dam (8.7891°N, 82.2155°W, 1050 m), Bosque Protector Palo Seco, Comarca Ngöbe-Buglé (formerly province of Bocas del Toro), Panama; collected by Andreas Hertz and Sebastian Lotzkat on 10 August 2010.

Paratypes. SMF 90180 (original field number SL 494; Fig 1D), juvenile male, same locality as holotype; collected by Andreas Hertz and Sebastian Lotzkat on 29 October 2009; SMF 89550 (original field number LSt 015; Fig 1E), juvenile, from Cerro Mariposa near Alto de Piedra, approx. 3.5 km W of Santa Fé, 8.5001°N, 81.1170°W, 1260 m, province of Veraguas, Panama; collected by Sebastian Lotzkat and Andreas Hertz on 28 May 2008.

Diagnosis. *Sibon noalamina* differs from all described species of *Sibon,* and from all other Central American snail-eaters, in its slight keeling on the third to fifth dorsal row at midbody in adults, and, most obviously, in having only five supralabials, with the fifth and ultimate one being the only supralabial posterior to the orbit (versus two supralabials posterior to orbit in all other species of *Sibon*) and exhibiting a peculiar shape: Its anterior portion is almost twice as high as the remaining supralabials, resembling the enlarged penultimate supralabial of other *Sibon*. Then it decreases in height towards the posterior portion that is about as high as the third supralabial, resembling the ultimate, usually moderately-sized, supralabial of other *Sibon*.

Additionally, its contrasting color pattern of complete dark rings on light background distinguishes *S. noalamina* from all Lower Central American *Sibon* except *S. anthracops* (Cope), from which it differs by having 15 dorsal rows throughout the body (vs. 13 in *S. anthracops*). At first sight, especially the more contrastingly colored juveniles of the new species might be confused with the coral snake-mimics *Dipsas articulata*, *D. bicolor* (Günther), *D. temporalis* (Werner), or *D. viguieri* (Bocourt). From these, *S. noalamina* is distinguished by the presence of a mental groove (lacking in the genus *Dipsas*), lower ventral counts (164–177 vs. 196–217 in *D. articulata*, 186–199 in *D. bicolor,* 170–208 in *D. temporalis,* and 190–203 in *D. viguieri*), the unique supralabial condition (5 supralabials with only the ultimate, peculiarly shaped one posterior to orbit versus 9–10 supralabials in *D. articulata,* 10–11 in *D. bicolor,* 7–8 in *D. temporalis,* and 9–10 in *D. viguieri,* all shaped similarly, with three or more, rarely two, posterior to orbit), and fewer infralabials (6–7 infralabials versus 11–12 in *D. articulata,* 10–11 in *D. bicolor,* 8–13 in *D. temporalis,* and 9–11 in *D. viguieri*). Furthermore, *S. noalamina* differs from *D. temporalis* in retaining the contrast between light and dark rings throughout body and tail (Fig. 1), whereas in *D. temporalis* the light portions grade into medium to dark brown posteriorly (Fig. 5H).

Description of the holotype. Adult male (Figs. 1A–C, 2–3), as indicated by everted hemipenes; SVL 385 mm, TL 161 mm (but tail incomplete); TOL 546 mm; HL 12.4 mm; HW 8.2 mm; SL 3.5 mm. Head distinct from neck; snout short, blunt in dorsal and lateral outline; rostral wider (2.1 mm) than high (1.3 mm), not extending posteriorly between internasals, its length visible from above one fifth length of median internasal suture (1.0 mm); internasals shorter (1.1 mm) than wide (1.7 mm), their length between one half and two-thirds length of prefrontal suture (1.9 mm); prefrontals shorter (2.5 mm) than wide (2.8 mm), their median suture (2.1 mm) about three-fifths length of frontal; prefrontals bordering eye above loreal; frontal longer (3.6 mm) than wide (3.0 mm), widest anteriorly, length almost two-thirds that of parietal, in contact with prefrontals, supraoculars, and parietals; supraoculars longer (3.4 mm) than wide (1.7 mm), nearly as long as frontal; parietals longer (5.8 mm) than wide (3.8 mm), widest anteriorly, their median suture (4.1 mm) slightly longer than frontal; parietals in contact with frontal, supraoculars, upper postoculars, anterior and posterior temporals, and nine nuchal scales; nasal divided, in contact with first two supralabials, loreal, prefrontal, internasal, and rostral; loreal single, longer (1.9 mm) than high (1.0 mm), its length more than one-half length of snout, and two-thirds length of eye (2.8 mm); preoculars absent; postoculars 2; temporals 1+2/2+2, all above fifth supralabial; supralabials five, with third and fourth bordering eye (enlarged anterior portion of ultimate supralabial separated from eye by lower postocular); fifth and ultimate supralabial conspicuously long (3.9 mm), longer than combined lengths of third and fourth supralabials, with a higher (1.7 mm) anterior and a lower (1.2 mm) posterior portion; pupil vertically elliptical; eye length one and a half times length of loreal; infralabials 6, first pair in contact behind mental; no postmental; infralabials 1–4 in contact with anterior chin shields; anterior chin shields paired, longer (2.8 mm) than wide (1.3 mm), longer than posterior chin shields; posterior chin shields longer (1.9 mm) than wide (1.4 mm), paired, in broad contact medially; mental groove present; ventrals 170; cloacal scute single; subcaudals 80 (but tail incomplete), divided; ventrals plus subcaudals 250 (but tail incomplete); dorsal scales mostly smooth, but slightly keeled on dorsal rows 3–5 around midbody, striate, in 15–15–15 rows, without apical pits or supracloacal ridges; vertebral row slightly enlarged.

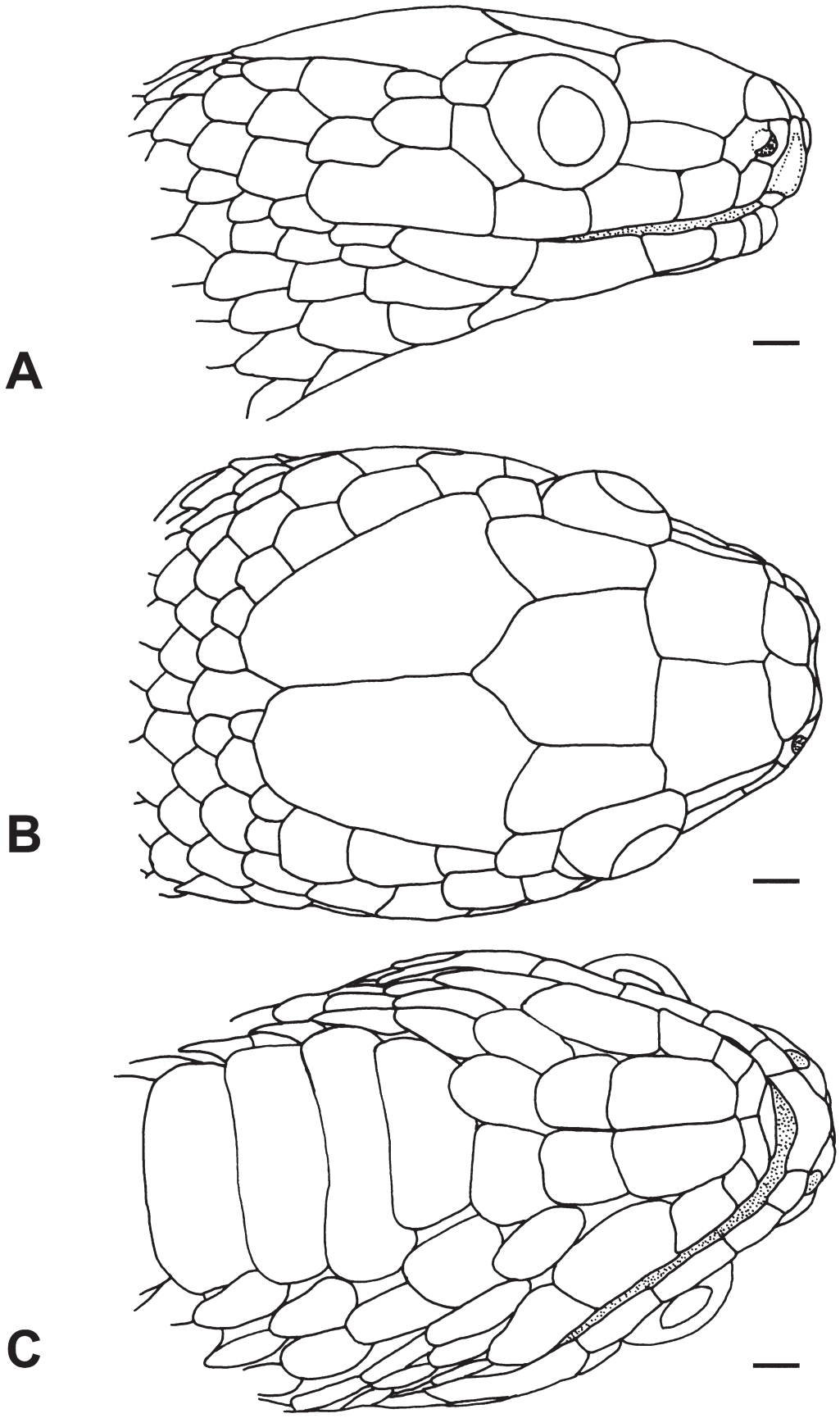

FIGURE 2. Head of Holotype (SMF 91539) of *Sibon noalamina:* (A) lateral (right side), (B) dorsal, and (C) ventral views. Scale bars equal 1 mm.

The fully everted hemipenis (Fig. 3) is a stout unilobed capitate organ; the capitulum is covered by calyces bearing spinules; no naked pocket; the sulcus spermaticus is bordered by well-developed sulcal lips, bifurcates at the base of apex with the branches continuing onto the apex; truncus with two series of large recurved spines.

Coloration in life. Dorsal, lateral, and ventral surfaces of body and tail Pale Horn Color (92); body with 14, tail with eight broad Sepia (219) rings, body rings extending over 6–12 middorsal scales, narrowing towards and on venter; interspaces between these rings extending over 3–6 middorsal scales, speckled with Sepia (219) except for narrow portions immediately adjacent to the dark rings; tip of (incomplete) tail Sepia (119); dorsal and lateral surfaces of head Pale Horn Color (92), grading into Flesh Ocher (132D) anteriorly, heavily mottled with Sepia (219); parietals, frontal, and central portions of prefrontals almost completely Sepia (219), as well as the middorsal scales of the first two transverse rows of dorsals posterior to parietals, connecting Sepia (219) coloration to first body ring; ventral surface of head Pale Horn Color (92) mottled with Sepia (219), especially on infralabials; iris Sepia (119). Color after ten months in preservative (70% ethanol) is similar to that in life, apart from that all yellow and orange shades have faded.

FIGURE 3. Hemipenis of Holotype (SMF 91539) of *Sibon noalamina:* (A) sulcate, (B) asulcate view. Scale bar equals 1 mm.

Variation. The juvenile paratypes (SMF 89550, Fig. 1E; and SMF 90180, Fig. 1D) agree well with the holotype in terms of general morphology and pholidosis (even in their tails being incomplete), differing mostly in their lack of any keels on dorsal rows 3–5 and in their somewhat more contrasting coloration. Scale counts that differ from that of the holotype are as follows: ventrals 164 (SMF 89550), 177 (SMF 90180); subcaudals 93, 96 (both tails are incomplete); ventrals plus subcaudals 257, 273 (but both tails are incomplete); temporals 1+2/1+2 in both, anterior temporals of both sides entering orbit between upper and lower postoculars (SMF 89550); parietals

bordered posteriorly by 8 nuchal scales in both; infralabials 6/7, 1–5 in contact with first chin shield on left side (SMF 89550). Body measurements of the juvenile specimens are SVL 178 mm, TL 68 mm (SMF 89550), SVL 161 mm, TL 64 mm (SMF 90180).

As illustrated in Fig. 1, the coloration in life of the juveniles presents a stronger contrast than that of the adult holotype. Moreover, the paratypes show variation in the relative width of dark and light rings. The latter appear most narrow in the juvenile from Veraguas (SMF 89550), which was recorded as follows (modified from Stadler 2010): Body and tail with alternating, complete dark and light rings; broader rings Jet Black (89), light rings Chamois (123D), about half as wide as, and becoming lighter toward, the dark rings; dorsal and lateral ground color of head Jet Black (89); crescent-shaped lateral markings on posterior portion of head and small blotches on snout Chamois (123D); ventral surfaces of head and neck Chamois (123D) mottled with Jet Black (89); iris black. The color after 37 months in preservative (70% ethanol) is similar to that in life, apart from that all yellow and orange shades have faded.

Natural history notes. All three specimens were encountered at night on vegetation. The juvenile SMF 89550 (Fig. 1E) from Cerro Mariposa, Veraguas, was moving through epiphytic liverworts growing on a small tree-trunk about 0.5 m above ground at 18:40 hrs, after a rainy afternoon. The habitat may be characterized as ridgetop cloud forest with abundant epiphytic vegetation. Annual precipitation is approx. 2500 mm, mean annual temperature approx. 20.2 °C, indicating the Premontane Wet Forest life zone according to the Holdridge (1967) classification. Other snail-eaters found at lower elevations on the slopes of Cerro Mariposa are *Dipsas temporalis, Sibon annulatus, S. longifrenis,* and *S. nebulatus*. A complete list of the herpetofauna documented around Cerro Mariposa was given by Stadler (2010), who also provided extensive data on climate and vegetation. Additionally, the herpetofauna of the general Santa Fé region was treated by Martínez and Rodriguez (1994 "1992"), Martínez *et al.* (1995 "1994"), and Carrizo (2010), and updated by Lotzkat *et al.* (2010).

Figure 1D shows the juvenile SMF 90180 as it was encountered at 19:40 hrs and 19.1 °C air temperature at the type locality: It was lying in loose coils upon a large leaf about 0.5 m above ground, in herbaceous secondary vegetation below the floodline of, and less than 10 m away from, a small stream. The holotype was found close to this stream while moving about in secondary forest, 2 m above ground at 23:00 hrs. The type locality is the valley of the mentioned stream, with rather undisturbed forest on the slope ascending northwards, minor clearings overgrown with grass and solitary trees directly by the riverside, and a more secondary forest on the slope ascending southward. Reptiles collected in this valley include *Anolis capito* Peters, *A. humilis* Peters, *A. limifrons* Cope, *A. lionotus* Cope, *Lepidoblepharis xanthostigma* (Noble), *Imantodes cenchoa* (Linnaeus), *Sibon annulatus,* and *Bothrops asper* (Garman). Annual total precipitation at the type locality is approx. 3000 mm, mean annual temperature approx. 20.6 °C, indicating the Premontane Wet Forest life zone according to the Holdridge (1967) classification. The datalogger recordings yielded a temperature range of 17.6–22.6 °C, with a mean of 19.4 °C and standard deviation ± 1.3 °C.

Geographic distribution. *Sibon noalamina* is hitherto only known from the highlands of western Panama (Fig. 4). The two known localities lie some 125 airline km apart, roughly at either end of the easternmost uninterrupted portion of the Cordillera Central, known as Serranía de Tabasará, which is approximately delimited to the west by the Fortuna depression and has its eastern limit in the region around Santa Fé. This indicates, as a minimum, a continuous distribution of the new taxon along the Caribbean versant of the Serranía de Tabasará, at premontane elevations between 1050 and 1260 m, most of it located in the Comarca Ngöbe-Buglé.

Etymology. The specific epithet is a contraction of the exclamation "no a la mina!", Spanish for "no to the mine", in the sense of "no mining". This affirmation was and is used by members of the indigenous Ngöbe communities living in the Serranía de Tabasará in the course of their protests against mining interests aiming to exploit their territory, especially around Cerro Colorado. The specific name is given in recognition and support of the Ngöbe's struggle to protect their territory and environment, which is home to the new species described herein and many others, from profit-driven destructive interventions.

Notes on other species of *Sibon* in western Panama

We report on distributional extensions and new morphological data resulting from specimens of *Sibon* that we collected in western Panama. All localities are shown in Figure 4 and specified in the Appendix. A summary of

selected characters observed among our Panamanian material (listed in the Appendix) is given in Table 1. Selected characters of all Lower Central American species of *Sibon* are compared in Table 2, taking into account the data presented by Köhler (2008), McCranie (2011), Savage (2002), and Solórzano (2004).

TABLE 1. Selected measurements and scale counts of Panamanian specimens of *Sibon* listed in the appendix. Ranges of ventral and subcaudal counts are followed by mean value ± one standard deviation. For abbreviations see text.

	Sibon annulatus	***S. longifrenis***	***S. nebulatus***	***S. noalamina***	***S. perissostichon***
	N = 19	N = 1	N = 7	N = 3	N = 1
SVL [mm]	139–427	279	267–612	161–385	458
TL [mm]	64–221	138	87–197	64–161 (incomplete)	210
TOL	203–648	417	354–809	225–546	671
TOL max ♂	648		809	546	
TOL max ♀	536	417	695		671
Ventrals	171–188 (182.4 ± 5.0)	147	179–195 (184.4 ± 5.7)	164–177	186
♂	180–188 (184.7 ± 2.1) n = 11		184–195 n = 2	170–177 n = 2	
♀	171–185 (178.0 ± 5.9) n = 4	147	179–188 (183.3 ± 4.0) n = 4		186
Subcaudals	103–130 (118.2 ± 7.3)	101	80–94 (88.4 ± 4.9)	80–96 (incomplete)	108
♂	113–130 (120.9 ± 4.9) n = 10		87–94 n = 2	80–96 (incomplete) n = 2	
♀	107–124 (117.0 ± 7.2) n = 4	101	80–93 (88.3 ± 5.7) n = 4		108
Ventrals + Subcaudals	278–312 (301.1 ± 9.6)	248	261–289 (272.9 ± 9.8)	250–273 (tails incomplete)	294
♂	299–312 (305.5 ± 4.0) n = 10		271–289 n = 2	250–273 (tails incomplete) n = 2	
♀	278–304 (295.0 ± 12.0) n = 4	248	261–279 (271.5 ± 8.6) n = 4		294
Dorsals at midbody	15	15	15	15	17
Postoculars	0–2	2	1–2	2	2–3
Anterior Temporals	1–2	1	1	1–2	1
Posterior Temporals	2–3	2	1–2	2	3
Supralabials	6–8	7	7–8	5	6
Supralabials contacting eye	1–3	2	2	2	1–2
Infralabials	6–8	7	8–9	6–7	7

TABLE 2. Selected measurements and scale counts of the nine species of *Sibon* known to occur in Lower Central America (Costa Rica and Panama), combining data from references listed in Materials and Methods as well as examined specimens listed in the appendix. Values from examined specimens that expand documented variation are in **bold** face, imperfect values owing to incomplete tails are in *italics*. For abbreviations see text.

	Sibon annulatus	***S. anthracops***	***S. argus***	***S. dimidiatus***	***S. lamari***	***S. longifrenis***	***S. nebulatus***	***S. noalamina***	***S. perisso-stichon***
TOL max [mm]	**648**	664	*690*	ca. 800	589	700	1013	546	671
♂	**648**	664		751		578	738	546	
♀	557	475		ca. 800		541	709		671
Ventrals	161–193	162–188	181–201	171–200	162–171	**147**–173	159–200	164–177	186
♂	170–193	166–187	181–201	184–200	162–163	166–173	159–200	170–177	
♀	161–186	162–186	186–192	171–196	168–171	**147**–168	161–193		186
Subcaudals	103–135	69–91	112–121	100–126	77–119	80–106	64–114	*80–96*	108
♂	108–133	80–91	112–121	113–126	77–108	95–106	75–114	*80–96*	
♀	107–124	69–83	*95–108*	100–122	112–119	80–**101**	64–100		108
Ventrals + Subcaudals	277–318	231–271	294–322	281–323		231–275	247–**289**	*250–273*	294
♂	278–318	248–271	294–322	303–323		263–275	262–**289**	*250–273*	
♀	277–**304**	231–269	*281–300*	271–317		231–263	247–**279**		294
Dorsal scale rows	15–15–15	13–13–13 (13–15–13)	15–15–15	15–15–15	15–15–15	15–15–15	15–15–15	15–15–15	15–17–15
Postmentals	1–2	0	0	1–2	1–2	0–1	0	0	1
Postoculars	**0**–2	2–3	2–3	1–2	2	1–3	1–4	2	2–3
Anterior Temporals	1–2	1–2	1–2	1–2	1	1–2	1	1–2	1
Posterior Temporals	1–3	2–3	2–3	2–3	2–3	1–3	1–2	2	3
Supralabials	**6**–9	6–8	6–9	7–9	7–8	7–9	5–9	5	6
Infralabials	**6**–10	7–9	6–9	7–12	8–10	6–9	6–10	6–7	7

Sibon annulatus.—Distribution: Savage and McDiarmid (1992) assumed *S. annulatus* to be restricted to the Atlantic slope of the Cordillera Central in western Panama, with only one record from Altos de Campana on the Pacific slope. However, SMF 88715 (Fig. 5A), SMF 91580, and in fact all our specimens from Veraguas, came from the Pacific drainage of the Cordillera Central. These records indicate a continuous distribution of this taxon along the Pacific slope, at least at premontane elevations in the Serranía de Tabasará, i.e., from the Fortuna depression eastward, where the continental divide drops below 1500 m repeatedly. The upper elevational limit of this species is given as 1300 m for Costa Rica (Savage 2002), and 910 m for Panama (Jaramillo *et al.* 2010). SMF 91580, an adult male found near Guayabito (Comarca Ngöbe-Buglé) at 1510 m, now constitutes the highest record from the Pacific slope. The female SMF 91578 (Fig. 5B), from 1640 m on the Atlantic slope at Río Changena (Bocas del Toro), is by far the highest record for this species.

Morphology: The presence of a pair of postmentals separating the first pair of infralabials has been considered typical for *Sibon annulatus* (Savage & McDiarmid 1992; Savage 2002; Köhler 2008). However, as already suggested by Köhler *et al.* (2010), this is definitely not the case among Panamanian specimens: only two (SMF 90208 and SMF 91578) of our 19 Panamanian specimens exhibit this condition, whereas the remaining 17 have a single postmental. Based on its single postmental, one of these specimens (SMF 85077) was erroneously labeled as *S. dimidiatus,* a species that to our knowledge does not occur in Panama, by Köhler (2008: p. 278: Fig. 752). Moreover, in one of our specimens (SMF 90208) the enlarged penultimate supralabial contacts the eye on both sides, a condition that has been considered to be restricted to *S. argus* and *S. longifrenis* (Savage & McDiarmid

1992; Savage 2002; Köhler 2008). About one-third of our specimens exhibit fusions of postoculars with adjacent scales on one or both sides of the head: Either the lower postocular is fused with the fifth supralabial, or the upper postocular with the supraocular, or (in one specimen) both. The male SMF 91580 raises the maximum TOL for this species to 648 mm.

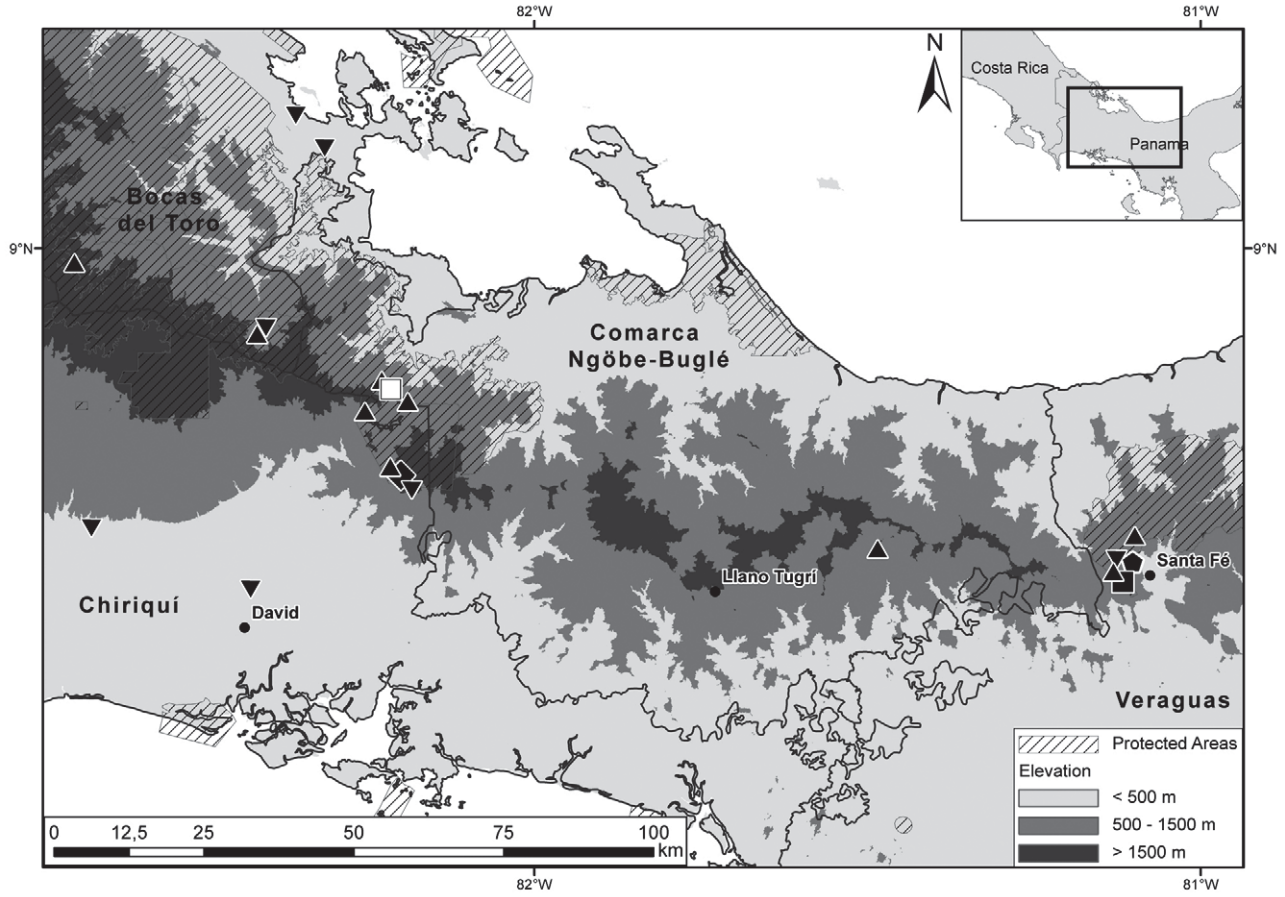

FIGURE 4. Collection localities of *Sibon noalamina* (squares, hollow symbol represents type locality), *S. annulatus* (upright triangles), *S. longifrenis* (pentagon), *S. nebulatus* (inverted triangles), and *S. perissostichon* (diamond), as well as protected areas (hatched) in western Panama. One symbol may represent several specimens from different localities close to each other. At the localities for *S. noalamina* and *S. perissostichon,* the symbols of other species found at the same general locality are offset for better visibility.

Sibon longifrenis.—Distribution: The only specimen of this species we could secure (SMF 91581 from Cerro Mariposa, province of Veraguas, 8.5161°N, 81.1185°W, 900 m; Fig. 5C) narrows the gap between the type locality (Isla Colón, province of Bocas del Toro, about 150 km northeast) and Parque Nacional General de División Omar Torrijos Herrera near El Copé (province of Coclé, about 60 km west-northwest; Ray *et al.* 2012). It also extends the known upper vertical limit for this species 100 m upwards from the highest record found in literature (800 m in Costa Rica according to Solórzano 2004).

Morphology: The female specimen has 147 ventrals, which is the lowest number of ventrals reported so far for *Sibon longifrenis* (Savage & McDiarmid 1992; Köhler 2008). It lacks a postmental scale, a condition known only from one specimen so far (KU 25703 according to Savage & McDiarmid 1992), allowing contact between the mental and the first pair of chin shields. Most notably, its enlarged penultimate (sixth) supralabial is not in contact with the eye on both sides of the head. This condition is only known from one side of the head of one specimen (McCranie 2011), whereas all previous authors considered the contact between eye and the penultimate supralabial one of the key characteristics of *S. longifrenis*.

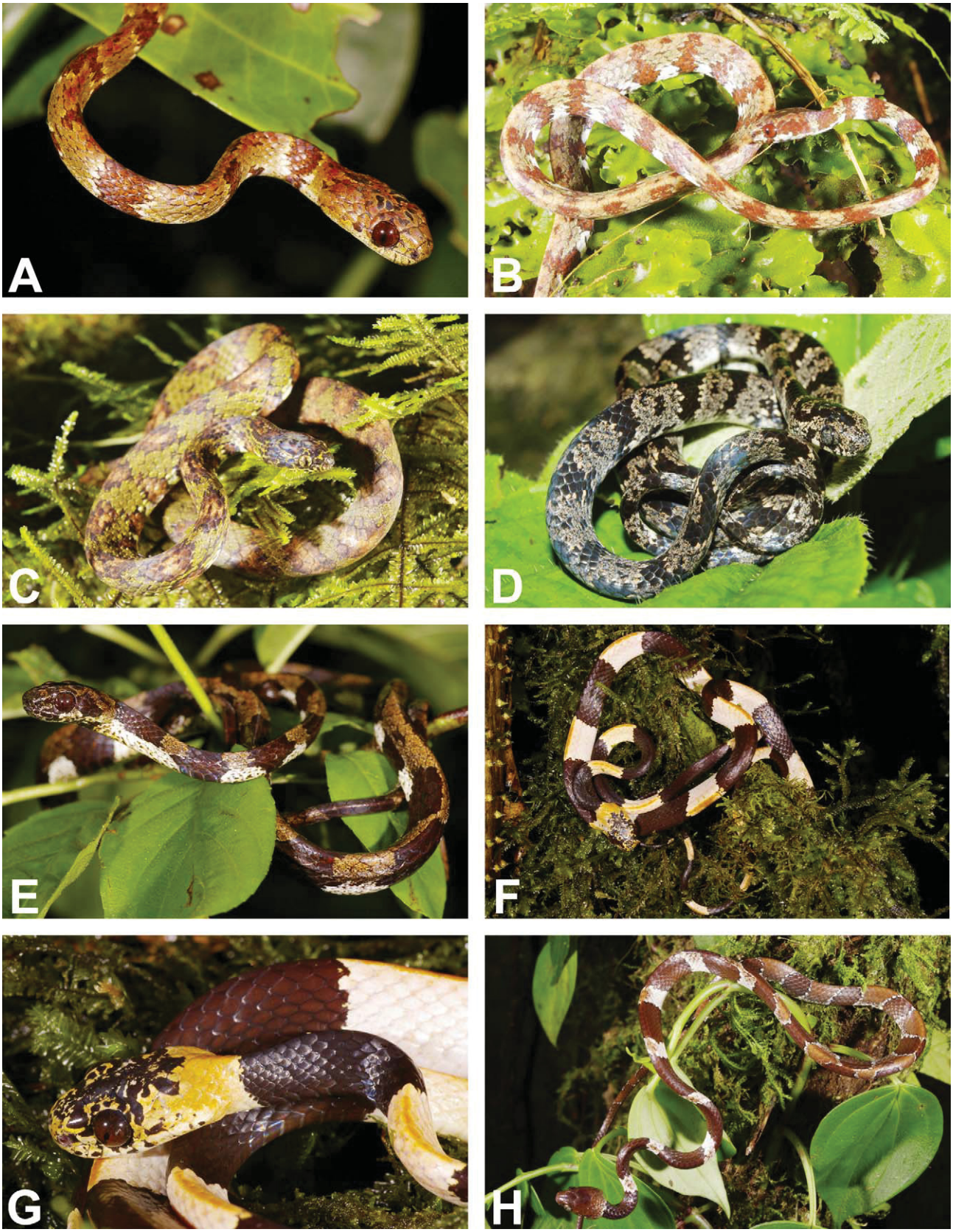

FIGURE 5. Snail-eaters collected in western Panama: (A) *Sibon annulatus* (La Fortuna, SMF 88715), (B) *S. annulatus* (Río Changena, SMF 91578), (C) *S. longifrenis* (Cerro Mariposa, SMF 91581), (D) *S. nebulatus* (La Fortuna, SMF 90209), (E) *S. perissostichon* (La Fortuna, SMF 88716), (F) and (G) *Dipsas articulata* (Cerro Negro, SMF 89952), (H) *D. temporalis* (Cerro Negro, SMF 89769).

Key to the Lower Central American species of *Sibon*

1 Seventeen rows of dorsal scales at midbody and 15 rows one head length anterior to cloaca; dorsal scale rows changing orientation from the sides of body towards middorsum . . . . . *Sibon perissostichon* (Fig. 5E)
- Thirteen or 15 rows of dorsal scales at midbody, usually without reduction on posterior portion of body; dorsal scale rows oriented longitudinally 2
2 Thirteen dorsal rows, both at midbody and one head length anterior to cloaca (very rarely 15 rows at midbody, but then 13 both one head length posterior to head and anterior to cloaca); coral snake-like pattern of alternating light and dark rings. . . . . *Sibon anthracops*
- Fifteen dorsal rows, both at midbody and one head length anterior to cloaca 3
3 Five supralabials; only one supralabial posterior to orbit, this ultimate one with a higher anterior and a lower posterior portion (Fig. 2A); coral snake-like pattern of alternating light and dark rings (Fig. 1) . . . . . *Sibon noalamina*
- Six or (in most cases) more supralabials, two supralabials posterior to orbit, with the penultimate one greatly enlarged; coloration variable, but no conspicuous coral snake-like pattern of alternating light and dark rings (for example Figs. 5A–D) 4
4 Enlarged penultimate supralabial usually in contact with eye; dorsal ground color greenish, with an ocellated or blotched rather than a banded or striped pattern; these dark dorsal markings reach at most to outer edges of ventrals, although dark shading or mottling may be present on venter 5
- Enlarged penultimate supralabial usually not in contact with eye; dorsal color pattern banded or striped rather than ocellate or blotched; these dark dorsal markings reach well onto venter or even across venter 6
5 181–201 ventrals; 112–121 subcaudals; body very slender; head blunt and very distinct from neck; eyes conspicuously large and protuberant . . . . . *Sibon argus*
- 147–173 ventrals; 80–106 subcaudals; body rather stout; snout acuminate, head gradually narrowing towards neck; eyes not conspicuously large, nonprotuberant . . . . . *Sibon longifrenis* (Fig. 5C)
6 First infralabials in contact with each other behind the mental . . . . . *Sibon nebulatus* (Fig. 5D)
- First infralabials separated from each other by one or two postmentals behind the mental 7
7 Bands dark brown ventrally; laterally, their centers are of a paler brown, which is paler than their borders or the interspaces between the bands; usually a single postmental . . . . . *Sibon dimidiatus*
- Bands dark brown ventrally and laterally, their centers not paler brown than their borders laterally, and darker than interspaces; one or two postmentals present 8
8 Dorsal surface of head with green or yellow as well as red and black markings; ground color of body green; 162–171 ventrals; 77–119 subcaudals. . . . . *Sibon lamari*
- Dorsal surface of head with pale and dark brown markings; ground color of body usually olive to pale brown; 161–193 ventrals; 103–135 subcaudals . . . . . *Sibon annulatus* (Figs. 5A–B)

Discussion

The new species has the lowest number of supralabials of all described *Sibon*. Moreover, the condition of the ultimate supralabial and the slight but discernible keeling on some lateral rows of dorsal scales are unique among the members of this genus. These characters readily distinguish *S. noalamina* from all congeners, rendering the species well separated morphologically. While its coral snake-like color pattern already distinguishes the new species from any Lower Central American *Sibon* except *S. anthracops* (from which it differs significantly in dorsal scale row number), it might lead to mistaking especially juvenile specimens for bicolored coral snake-mimics of the genus *Dipsas,* most probably the sympatric *D. articulata* (Figs. 5F–G). Although this may seem trivial, such confusion has already occurred: The juvenile paratype SMF 89550 has been referred to as *D. articulata* in a diploma thesis (Stadler 2010) and a book (Köhler 2008: p. 219: Fig. 592).

Apart from individual variation concerning the relative width of light and dark rings, specimens of *Sibon noalamina* apparently undergo ontogenetic changes both in scale surface configuration and coloration. The keeling on dorsal rows 3–5 is absent in the juvenile paratypes but obvious in the adult holotype. Likewise, the adult exhibits a less contrasting color pattern with the dark components appearing much lighter than in the juveniles, and the light rings being darkened by an increased mottling especially in their central portions. Whether the observed differences in the extent of dark coloration on the head are the result of individual or ontogenetic variability remains unclear.

Concerning the geographic distribution of *Sibon noalamina,* the available data indicate premontane elevations between 1050 and 1260 m along the Caribbean versant of the Serranía de Tabasará. We expect that both horizontal and vertical limits of the species' areal extent will be expanded by future fieldwork in the premontane forests of the Cordillera Central. Nevertheless, until demonstrated otherwise, the species is to be regarded as endemic to Panama, and more precisely, to the Serranía de Tabasará. Although comparatively little fieldwork has been carried out in this mountain chain, it is known to house several endemic reptiles, namely *Anolis casildae* Arosemena, Ibañez and

De Sousa, *A. gruuo* Köhler, Ponce, Sunyer and Batista, *A. pseudokemptoni* Köhler, Ponce, Sunyer and Batista, *A. pseudopachypus* Köhler, Ponce, Sunyer and Batista, and *Sibon perissostichon*. Among amphibians, the rainfrogs *Diasporus citrinobapheus* Hertz, Hauenschild, Lotzkat and Köhler and *D. igneus* Batista, Ponce and Hertz have recently been added to the list of vertebrates endemic to the Tabasará range (Hertz *et al.* 2012a; Batista *et al.* 2012). Moreover, Hertz *et al.* (2012b) revealed the Serranía de Tabasará to shelter surviving populations of various endangered amphibian species, some of which have not been detected elsewhere since the outbreak of chytridiomycosis in Lower Central America.

Despite forming the eastern portion of the Talamancan Highlands sensu Savage (2002) and obviously constituting a hotspot of endemism of its own, virtually nothing of the Serranía de Tabasará is integrated into any protected area but its very extremes to the east and west (Fig. 4). That is to say, situated within areas protected by Panamanian law are currently only the westernmost populations of *A. casildae, A. pseudopachypus, S. noalamina,* and *S. perissostichon* (Bosque Protector Palo Seco and Reserva Forestal La Fortuna; Köhler *et al.* 2010; Lotzkat *et al.* 2010, unpublished data), and the easternmost populations of *A. gruuo* and *S. noalamina* (Parque Nacional Santa Fé; Lotzkat *et al.* 2012). By far most of the distributional ranges of *A. casildae, A. gruuo, A. pseudopachypus* and *S. noalamina,* presumably a great portion of the range of *S. perissostichon,* as well as the entire documented range of *A. pseudokemptoni,* fall outside any protected area.

This unprotected, more than 100 km long stretch inside the indigenous autonomy region Comarca Ngöbe-Buglé has been in the focus of international mining interests for a long time. Especially the region known as Cerro Colorado recently seems to be the object of an increasing attention again, fueled by new laws that favor and facilitate related activities (Nakoneczny & Whysner 2010). These interests, as well as plans for the construction of numerous hydroelectric dams in the Comarca, severely threaten the region's natural environments with destruction, and accordingly are fiercely opposed against by the indigenous population that depends on its environment. Even worse, the circumjacent Comarca Ngöbe-Buglé suffers the highest deforestation rate of any Panamanian subdivision, having lost more than one-fifth of its forest cover during just eight years at the end of the past century (ANAM 2009). Indeed, a great portion of the Serranía de Tabasará is subject to ongoing heavy deforestation whitnessed by ourselves. Repeating once more the conclusions of Hertz *et al.* (2012b) and Lotzkat *et al.* (2012), we sincerely hope that Panamanian authorities will realize the inherent value of these highlands' exuberant biodiversity and, in due collaboration with the indigenous authorities, consequently initiate steps to protect and sustainably use it, instead of merely pursuing quick profits from precious metals.

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APPENDIX

Comparative material examined.

Dipsas articulata.—**Nicaragua:** Río San Juan: Bartola, 10.9728°N, 84.3392°W, 30 m: SMF 81010; **Panama:** Veraguas: Cerro Negro, 8.5756°N, 81.0976°W, 1000 m: SMF 89952.

Dipsas temporalis.—**Panama:** Veraguas: Cerro Mariposa, 8.5150°N, 81.1196°W, 910 m: SMF 89551; Cerro Mariposa, 8.5107°N, 81.1207°W, 990 m: SMF 89552; Cerro Mariposa, 8.5245°N, 81.1332°W, 700 m: SMF 89553; Cerro Mariposa, 8.5237°N, 81.1335°W, 720 m: SMF 89554; Cerro Mariposa, 8.5117°N, 81.1216°W, 900 m: MHCH 2311; Cerro Negro, 8.5690°N, 81.0989°W, 700–710 m: SMF 89769, 89953, 90036.

Sibon annulatus.—**Honduras:** Colón: Reserva de Biósfera Río Plátano, El Ocotillal, Cabeceras de Río Plátano, 370 m: SMF 86014; Gracias a Dios: Reserva de Biósfera Río Plátano, Pomokir, 150 m: SMF 86013; **Nicaragua:** Atlántico Norte: Parque Nacional Saslaya**,** Campamento Los Monos, 13.7517°N, 85.0367°W, 850 m: SMF 79655; Jinotega: Reserva Biosfera Bosawas, ca. 0.5 km SE Pueblo Wiso, 13.9933°N, 85.3267°W, 200 m: SMF 78369; Matagalpa: Cerro Musún, Palán, Bilampí, 13.0114°N, 85.2366°W, 620 m: SMF 88180; **Panama:** Bocas del Toro: Río Changena, 8.9785°N, 82.6901°W, 1640 m: SMF 91578; Pianista trail, Casa de Ancón, 8.8714°N, 82.4159°W, 1010 m: SMF 86411, 88713–14; Chiriquí: Reserva Forestal La Fortuna, 8.7776°N, 82.2092°W, 1030 m: SMF 85077–78; Reserva Forestal La Fortuna: Cerro Guayabo, 8.7553°N, 82.2543°W, 1250 m: SMF 90208; Reserva Forestal La Fortuna: near Lost&Found Ecohostel, 8.6739°N, 82.2185°W, 1320 m: SMF 88715; Comarca Ngöbe-Buglé: Bosque Protector Palo Seco: headwaters of Río Chiriquí Malí, 8.7891°N, 82.2155°W, 1050–1080 m: MHCH 2363–4, SMF 90207, 91579; near Guayabito, 8.5494°N, 81.4847°W, 1510 m: SMF 91580; Veraguas: Cerro Mariposa, 8.5249°N, 81.1328°W, 680 m: SMF 89596; Cerro Mariposa, 8.5146°N, 81.1193°W, 1000 m: SMF 89597; Cerro Mariposa, 8.5082°N, 81.1210°W, 900 m: MHCH 2365; Cerro Negro, 8.5690°N, 81.0989°W, 900 m: SMF 89786; Cerro Negro, 8.5770°N, 81.0971°W, 1090 m: SMF 90024; Cerro Negro, 8.5690°N, 81.0989°W, 680 m: SMF 90023.

Sibon anthracops.—**Costa Rica:** Guanacaste: Volcan Rincon de la Vieja: SMF 77133; **El Salvador:** no additional locality data: SMF 68197; La Libertad: Santa Tecla, Pinares de Suiza: SMF 81286; San Salvador: San Salvador: SMF 79239; **Guatemala:** Zacapa: San Vicente, Aldea Santa Elena: SMF 82594; **Nicaragua:** Carazo: Diriamba: KU 174287; Estelí: 15 km E Estelí, 800 m: KU 116975; Granada: Volcan Mombacho: SMF 81024; Managua: 1 mi N Sabana Grande: KU 42299; 6 mi WSW Sabana Grande: KU 42300; 8 km on South road: KU 174286; Casa Colorada, Las Nubes: KU 174282–85; Rivas: Morgan´s Rock, 11.3080°N, 85.9164°W, 35–265 m: JS field numbers 806, 838, SMF 88971–72.

Sibon dimidiatus.—**Honduras:** Copán: near Quebrada Grande, 1300 m: SMF 79119; **Nicaragua:** Matagalpa: Selva Negra, 12.9993°N, 85.9092°W: SMF 77800, 77860, 79027–28; Matagalpa: BMNH 1894.7.26.45.

Sibon longifrenis.—**Costa Rica:** Heredia: Puerto Viejo de Sarapiquí, 50 m: SMF 79966; **Honduras:** Gracias a Dios: Reserva de Biósfera Río Plátano: SMF: 86012; **Nicaragua:** Jinotega: Bosawas, Kulum Kitang, 14.3300°N, 84.9367°W, 180 m: SMF 88182; **Panama:** Veraguas: Cerro Mariposa, 8.5161°N, 81.1185°W, 900 m: SMF 91581.

Sibon nebulatus.—**Costa Rica:** Guanacaste: Volcan Arenal: SMF 77134; **El Salvador:** Ahuachapán: Parque Nacional El Imposible, La Fincona, 720 m: SMF 81283; **Honduras:** Atlántida: La Ceiba: SMF 79879; **Nicaragua:** Atlántico Norte: Waní, Siuna: UCA 214; Big Falls, Río Pis Pis: AMNH 12682; Rancho Alegre, 13.6632°N, 85.0108°W, 315 m: SMF 85510; Bosawas, Muru Lak, 14.3535°N, 84.9420°W, 185 m: SMF 87225; Parque Nacional Saslaya, Cerro El Toro, 830 m: SMF 83122; Atlántico Sur: Kukra: AMNH 12680–81; betw. Kukra and Kanawa: AMNH 12679; Isla del Maíz Grande: AMNH 97068–70; Isla del Maíz Grande, Mt. Pleasant: KU 174303; Boaco: near Boaco: KU 174302; Granada: Volcán Mombacho, near lower antenna, 11.8332°N, 85.9795°W, 1100 m: SMF 79561, 79835; Managua: Casa Colorada, El Crucero: KU 174295–99; Casa Colorada, Las Nubes: KU 174288–994, 174300; Nueva Segovia: 5 km N, 2.5 km E Jalapa, 680 m: KU 112982 ; Río San Juan: Los Guatuzos, Río Frío, Fundeverde, 11.0769°N, 84.7488°W, 45 m: SMF 87266; Los Guatuzos, along Río Papaturro, 11.0227°N, 85.0513°W, 40 m: JS field number 995; near El Castillo, finca of John Kinlach: KU 174301; Río San Juan, Boca de San Carlos, 10.7877°N, 84.1950°W, 20 m: SMF 79836; Río San Juan, Bartola, 10.9728°N, 84.3392°W, 30 m: CRB 011–13, SMF 79837; Camp Machado: USNM 19558; San Juan del Norte: USNM 5571, 62997. **Panama:** Bocas del Toro: Road to Almirante, Km 43, 9.1572°N, 82.3182°W, 50 m: SMF 89787; Road to Almirante, Km 53, 9.2061°N, 82.3616°W, 50 m: MHCH 2367; Pianista trail, Casa de Calixto, approximately 8.8810°N, 82.4100°W, 870 m: SMF 88717; Chiriquí: Los Algarrobos: Casa Culebra, 8.4953°N, 82.4294°W, 130 m: MHCH 2366; Reserva Forestal La Fortuna: Lost&Found Ecohostel, 8.6746°N, 82.2196°W, 1250 m: SMF 90209; Volante, 8.587°N, 82.6683°W, 480 m: SMF 89599; Veraguas: Cerro Mariposa, 8.5122°N, 81.1214°W, 930 m: SMF 89598.

Sibon perissostichon.—**Panama:** Chiriquí: Reserva Forestal La Fortuna: near Lost&Found Ecohostel, 8.6744°N, 82.2161°W, 1434 m: SMF 88716 (holotype).